

REMARKS

Claims 1-5 and 15-18 are pending in this application, with claims 1, 5, and 15 being independent claims. Claims 6-13 have been withdrawn from further consideration by the Examiner. Claim 14 has been cancelled and claims 1, 5, and 15 have been amended to more clearly recite features of the present invention. No new matter has been entered.

In the Office Action, the Examiner: rejected claim 14 under 35 U.S.C. § 102(e) as being anticipated by Vitkavage et al. (U.S. Patent No. 5,858,873); and rejected claims 1-5 and 15-18 under 35 U.S.C. § 103(a) as being unpatentable over Vitkavage et al. in view of Gesheva et al. (Ceramics International 22 (1996), pp. 97-89).

Applicant respectfully requests reconsideration and withdrawal of the rejections set forth in the Office Action.

REJECTIONS UNDER 35 U.S.C. § 102

Claim 14 stands rejected under 35 U.S.C. § 102(e) as being anticipated by Vitkavage et al., according to the rationale discussed in page 2 of the Office Action. This rejection is rendered moot by the cancellation of claim 14. Thus, reconsideration and withdrawal of this rejection is respectfully requested.

REJECTIONS UNDER 35 U.S.C. § 103

Claims 1-5 and 15-18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Vitkavage et al. in view of Gesheva et al., according to the rationale discussed on page 3 of the Office Action. Applicant respectfully traverses this rejection.

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com

Each of claims is drawn to a combination of elements that is patentable over the teachings of Vitkavage et al. and Gesheva et al. In particular, independent claim 1 recites, among other things, "a crystalline film containing tungsten, carbon, and nitrogen for preventing copper diffusion from the wiring layer to the insulator film, the crystalline film arranged between the insulator film and the wiring layer." Independent claim 5 includes similar recitations. Independent claim 15 recites, among other things, "a WC_xN_y crystalline film formed on the insulator," and "a wiring layer of copper formed on the crystalline film, wherein the crystalline film prevents copper diffusion from the wiring layer to the insulator film." As will be described, neither Vitkavage et al. nor Gesheva et al., taken either singularly or in combination, teaches or suggests the claimed invention.

Vitkavage et al. discloses an integrated circuit having a contact in a recess (10) of a silicon substrate (2). The contact includes an adhesion layer (12) deposited on an inner surface of the recess (10), an amorphous layer of silicide (16) deposited over the adhesion layer (12) within the recess (10), and a central plug (18) composed of a conductive material. A refractory material layer (14) having a crystalline structure is deposited over the adhesion layer (12). Vitkavage et al., however, fails to teach or suggest, among other things, a crystalline film containing tungsten, carbon, and nitrogen for preventing copper diffusion from the wiring layer to the insulator film, as recited in independent claims 1 and 5, and "a WC_xN_y crystalline film formed on the insulator," and "a wiring layer of copper formed on the crystalline film," as recited in independent claim 15.

Gesheva et al. discloses study of structural characterization and temperature dependence of the electrical resistance of W films and WC_xN_y films deposited on

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com

Si(100) substrates by CVD of $W(CO)_6$ and WCl_6 precursors. Gesheva et al. teaches that " WC_xN_y films deposited by CVD of $W(CO)_6$ in presence of ammonia and acetone show semiconductor behaviour; their electrical resistance decreases with increasing temperature."

While admitting the deficiency of Vitkavage et al., the Examiner alleges that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the crystalline film of Vitkavage et al. having a material containing tungsten, carbon, and nitrogen, such as taught by Gesheva et al. in order to prevent the diffusion of the wiring into the insulator film." In response, Applicant respectfully submits that the Examiner's allegation with respect to the cited prior art references does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103(a).

The Examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a *prima facie* case of unpatentability. To establish a *prima facie* case of obviousness, three basic criteria must be met. First, the prior art references when combined must teach or suggest all the claim elements. Second, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Finally, there must be a reasonable expectation of success. Furthermore, the teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in Applicants' disclosure. See MPEP § 2143.

As to the first criterion for a proper *prima facie* case of obviousness, the asserted combination of Vitkavage et al. and Gesheva et al. fails to teach or suggest all the

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com

claimed elements since the combination does not disclose, among other things, a crystalline film containing tungsten, carbon, and nitrogen or a WC_xN_y crystalline film for preventing copper diffusion from the wiring layer to the insulator film. For example, Vitkavage et al. specifically discloses that "this [refractory material] layer (14) does not serve as a good boundary layer to prevent diffusion of aluminum-alloy into silicon. Accordingly, the present invention provides an amorphous non-crystalline layer that is deposited over the layer (14)." See col. 4, lines 21-27, of Vitkavage et al. That is, the integrated circuit of Vitkavage et al. requires an amorphous, non-crystalline layer (16) over a refractory material layer (14) to prevent diffusion of a metal plug material. This clearly teaches away from the claimed invention since a crystalline film, as recited in the present claimed invention, cannot be used as a metal diffusion preventing film.

On the other hand, Gesheva et al. merely discloses structural characterization and temperature dependence of the electrical resistance of a crystalline films. However, nowhere in Gesheva et al. discloses that the WC_xN_y film is for preventing copper diffusion. In addition, even if Gesheva et al. does disclose the WC_xN_y film is for preventing copper diffusion, the WC_xN_y film still cannot be combined with Vitkavage et al. because Vitkavage et al. explicitly teaches that a crystalline film "does not serve as a good boundary layer." At least for this reason, the asserted combination of Vitkavage et al. and Gesheva et al. fails to teach or suggest a crystalline film containing tungsten, carbon, and nitrogen or a WC_xN_y crystalline film for preventing copper diffusion from the wiring layer to the insulator film. Thus, Applicant respectfully submits that the first criterion for a proper *prima facie* case of obviousness has not been met.

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com

As to the second criterion, there is no suggestion or motivation in either Vitkavage et al. and Gesheva et al. to combine or modify their teachings. In particular, it is unclear why one skilled in the art would be motivated to take the teachings of Gesheva et al. (i.e., no teaching or suggestion of copper diffusion preventing film, but mere disclosure of characterization and temperature dependence of WC_xN_y film) and combine them with an integrated circuit of Vitkavage et al. Applicant respectfully submits that a suggestion or motivation to modify or combine reference teachings must be found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. However, the Examiner's alleged motivation (i.e., "to prevent the diffusion of the wiring into the insulator film") does not appear to be based on any factual findings. Applicant also does not believe that such a combination would result in the present claimed invention since Vitkavage et al. specifically discloses that an amorphous, non-crystalline layer over a refractory material layer is required to prevent diffusion of a metal plug material. Therefore, Applicant respectfully submits that the second criterion for a proper *prima facie* case of obviousness also has not been met.

As to the third criterion, not only does the combination of cited references not result in the present claimed invention, but the combination also does not show a reasonable expectation of success. In particular, it is unclear as to how and in what manner the WC_xN_y film of Gesheva et al., in which no specific structure is disclosed, is incorporated in the integrated circuit of Vitkavage et al. which requires a non-crystalline, amorphous layer. In addition, the teaching or suggestion to make the claimed combination and the reasonable expectation of success is not found in the cited

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com

references. Therefore, the third criterion for a proper *prima facie* case of obviousness also has not been met.

At least for the reasons set forth above, Applicant believes that the claimed invention define novel and non-obvious subject matter over the cited prior art. Thus, Applicant respectfully requests reconsideration and withdrawal of this rejection.

Regarding claims 2-4 and 16-18, the Examiner alleges that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the crystalline film of Vitkavage et al. and Gesheva et al. having some properties as claimed because it depends to the desired contact resistance of the contact structure." While it is unclear as to what the Examiner meant by the phrase "depends to the desired contact resistance of the contact structure," Applicant respectfully submits that none of the cited prior art references, taken either alone or in combination, teach or suggest the subject matter recited in claims 2-4 and 16-18. In addition, claims 2-4 and 16-18 are also allowable at least by virtue of their dependency on allowable independent claims 1 and 15.

CONCLUSION

In view of the foregoing amendment and remarks, Applicant respectfully submits that the claimed invention is neither anticipated nor rendered obvious in view of the prior art references cited against this application. Applicant therefore requests the entry of this Amendment, reconsideration of the application, and the timely allowance of pending claims pending claims 1-5 and 15-18.

Applicant respectfully requests that this Amendment under 37 C.F.R. § 1.116 be entered by the Examiner, placing all pending claims in condition for allowance.

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com

Applicant submits that the proposed amendments of claims 1, 5, 15, and 16 do not raise new issues or necessitate the undertaking of any additional search of the art by the Examiner, since all of the elements and their relationships claimed were either earlier claimed or inherent in the claims as examined. Therefore, this Amendment should allow for immediate action by the Examiner. It is respectfully submitted that the entering of the Amendment would allow the Applicant to reply to the final rejections and place the application in condition for allowance.

Finally, applicant submits that the entry of the amendment would place the application in better form for appeal, should the Examiner dispute the patentability of the pending claims.

Attached hereto is a marked-up version of the changes made to claims 1, 5, 15, and 16 by this Amendment.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

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By 

David W. Hill
Reg. No. 28,220

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com

APPENDIX TO AMENDMENT

IN THE CLAIMS:

1. (Twice Amended) A semiconductor device comprising:
 - an insulator film formed on a substrate;
 - a wiring layer of copper formed proximate the insulator film; and
 - a crystalline film containing tungsten, carbon, and nitrogen for preventing copper diffusion from the wiring layer to the insulator film, the crystalline film arranged between the insulator film and the wiring [film] layer.
5. (Twice Amended) A semiconductor device comprising:
 - an insulator film formed on a substrate;
 - a crystalline film formed on the insulator film;
 - a wiring layer of copper formed on the [insulator] crystalline film; and
 - [a] the crystalline film for preventing copper diffusion from the wiring layer to the insulator film, the crystalline film formed of a material comprising tungsten, carbon, and nitrogen, the crystalline film arranged between the insulator film and the wiring layer.
15. (Amended) The semiconductor device [according to claim 14, wherein the crystalline film comprises] comprising:
 - an insulator film formed on a substrate;
 - a WC_xN_y crystalline film formed on the insulator film; and
 - a wiring layer of copper formed on the crystalline film,

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com

wherein the crystalline film prevents copper diffusion from the wiring layer
to the insulator film.

16. (Amended) The semiconductor device according to claim [14] 15, wherein the crystalline film, when subjected to X-ray diffraction, has a spectrum having a first peak between 36 degrees and 38 degrees and a second peak between 42 degrees and 44 degrees.

FINNEGAN
HENDERSON
FARABOW
GARRETT &
DUNNER LLP

1300 I Street, NW
Washington, DC 20005
202.408.4000
Fax 202.408.4400
www.finnegan.com